Tof studies with protons from Λ decays

August 15, 2003

(M. A. Ciocci, R. Carosi, P.Squillacioti, S.Torre)

Outline

- Motivation
- Λ yield optimization
- Use of Λ's for proton TOF studies
- Conclusion and to-do's ...

Motivation: p tag using Tof for $\Lambda_b \rightarrow ph^-$

This study is motivated by the need of separating Protons from Pions in the Background reduction for $\Lambda_b \rightarrow p h$, using TOF and dE/dx.

We will use Λ from the B_PIPI path[1]: large K^0 and Λ samples.

Large pions sample

Large protons sample

Protons from Λ with high momentum

Pions with low momentum

The Tof information of protons and pions can be used to explore some Tof performances:

Caveat: using K^0 and Λ we must take into account corrections for V^0 time of flight

1 http://www-cdf.fnal.gov/internal/physics/bottom/bhadronic/slides/030519/ciocci_v0_in_ttt.pdf

2 http://www-cdf.fnal.gov/internal/physics/bottom/reco-tag/TALKS/030620/torre_dEdx_06_20_2003.pdf

Λ selection from B_pipi path

Good runs of hbOt1h+hbpp08 datasets

- cdfsoft2 4.9.1hpt3
- CharmMods to select our V^0 candidates

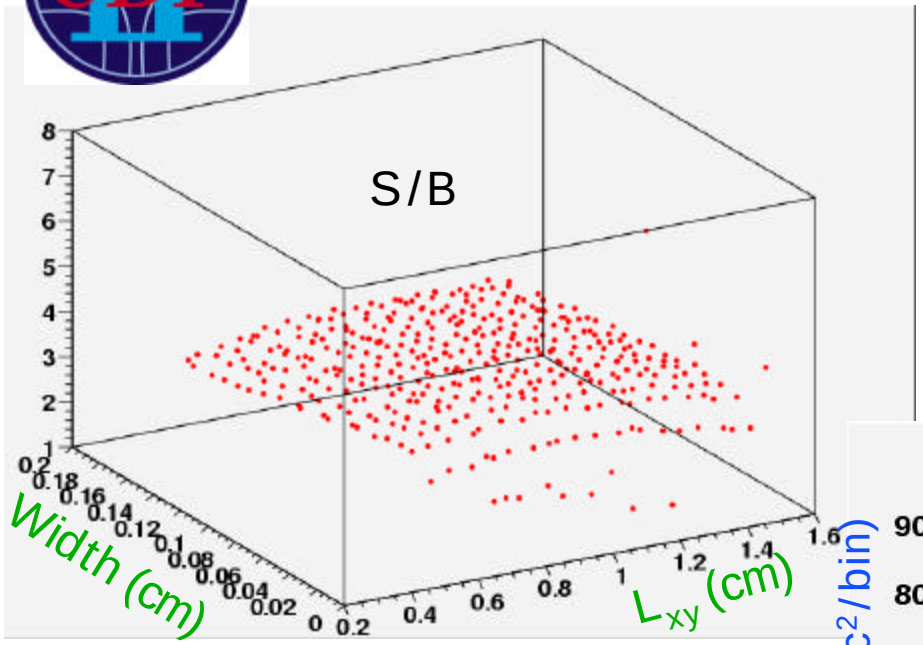
- Q1*Q2 < 0
- $P^t_{1,2}$ > 0.2 GeV/c
- HasCOTHits(24,24,2,2,6,6)
- 0.1 GeV/c^2< $M_{12}(\pi\pi$ Hyp) <1.5 GeV/c^2
- $|z_{01}-z_{02}|$ < 2 cm
- HasVertexFit & Lxy > 0.5 cm
- SumPt>1.1GeV/c
- χ^2 vertex < 10

In each plot

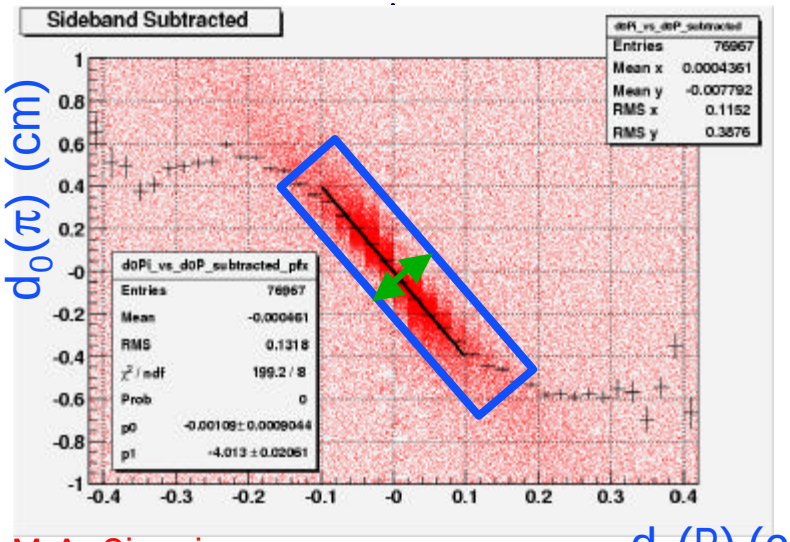
signal: $\pm 3\sigma$ window around the reconstructed V^0 mass peak

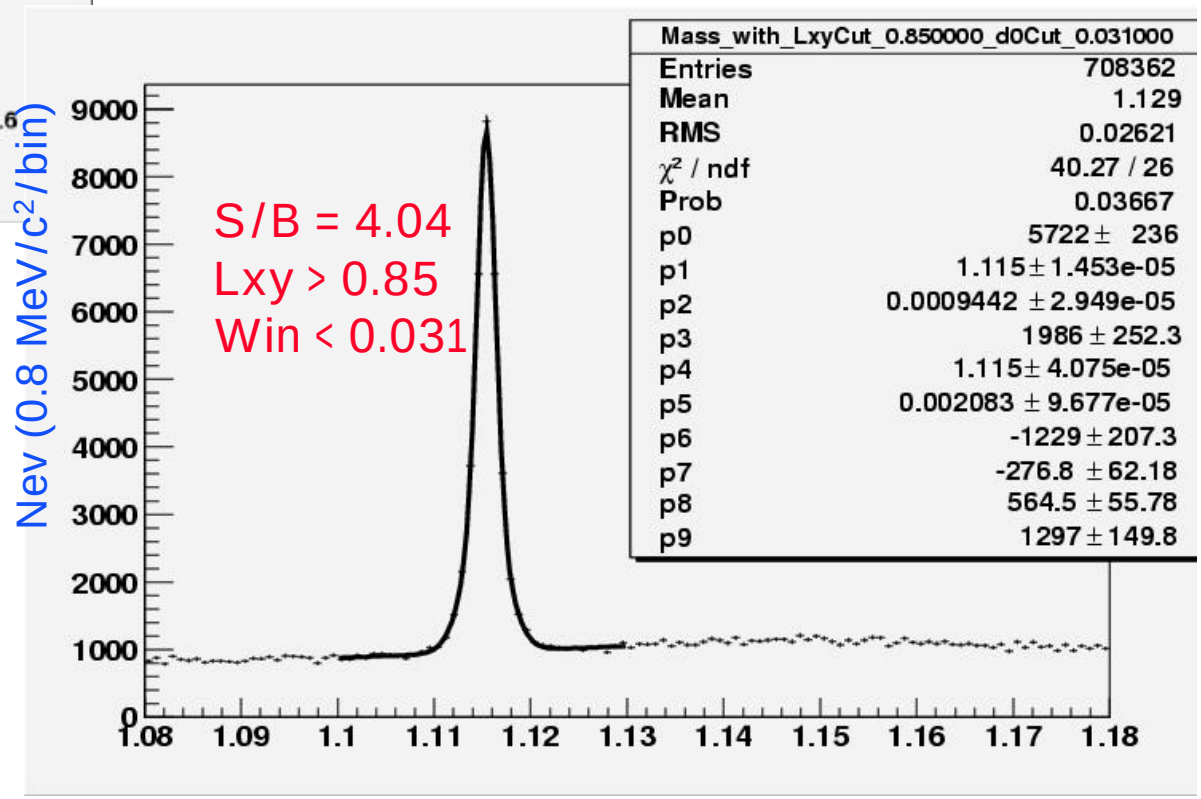
sidebands: $(M-10\sigma, M-7\sigma) \cup (M+7\sigma, M+10\sigma)$

Previous results Summary



optimized purity $\left(\frac{S}{B}\right)$ for Λ





Λ yield optimization

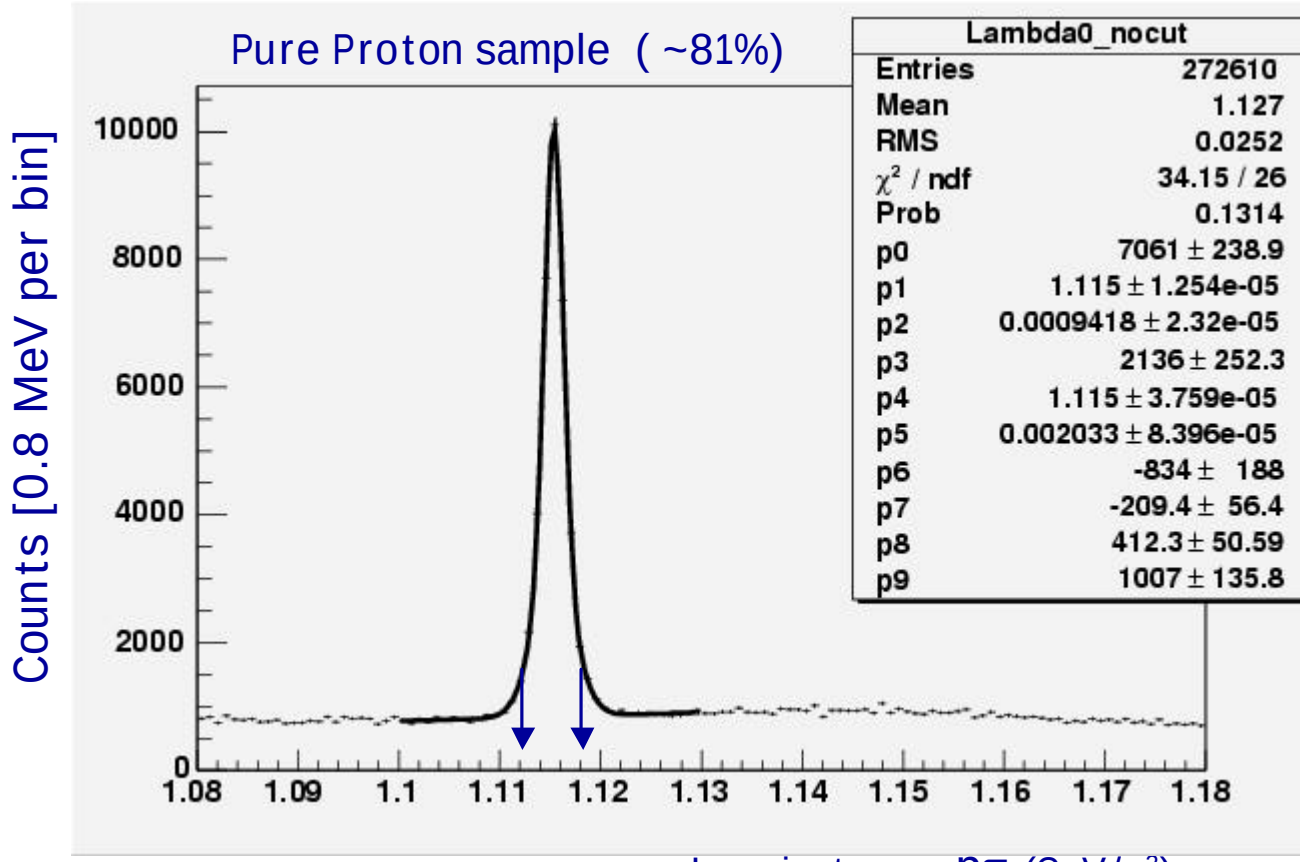
We need very High Λ purity: Reoptimized cuts adding the Λ I.P.

S/B = 5.4

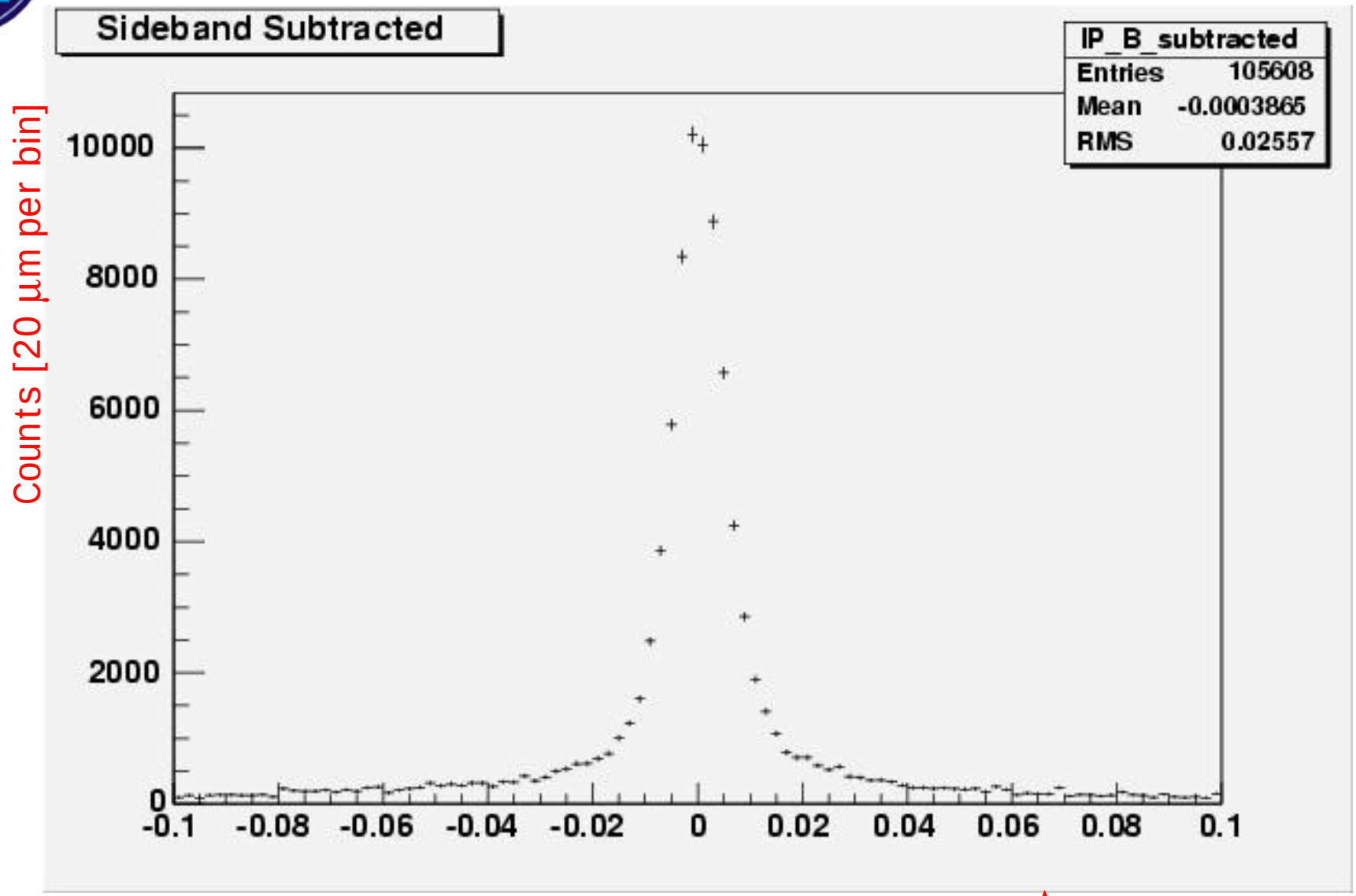
Lxy > 0.85

Win < 0.051

ABS(I.P.$_\Lambda$)<0.007 cm

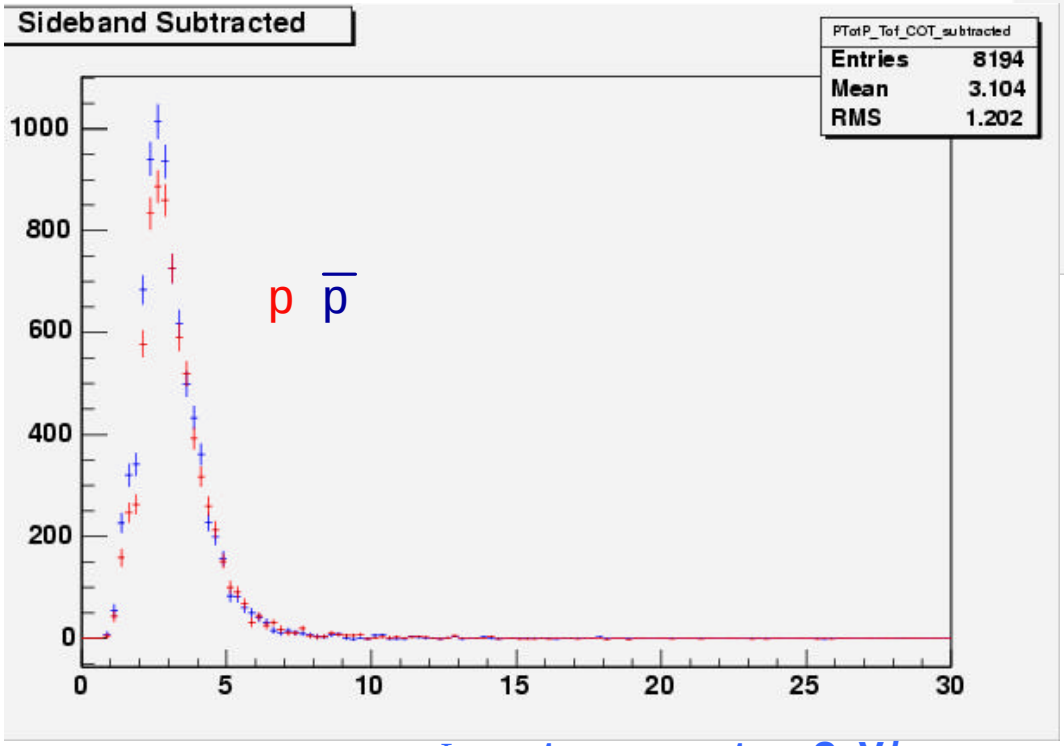


Λ I.P

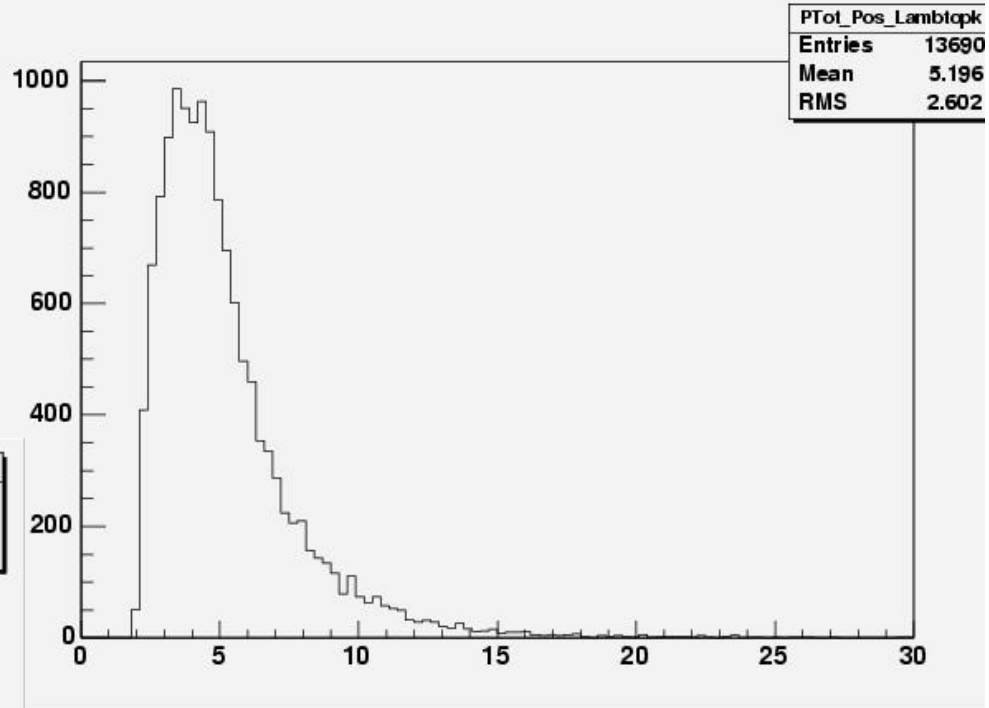

Sideband Subtracted
IP_B_subtracted
Entries 105608
Mean -0.0003865
RMS 0.02557
Counts [20 μm per bin]
10000
8000
6000
4000
2000
0
-0.1
-0.08
-0.06
-0.04
-0.02
0
0.02
0.04
0.06
0.08
0.1
Λ I.P [cm]

Λ_b and Λ Proton momentum

Protons from Λ allow to evaluate the performances of Tof for proton tagging in the momentum range between 1.5 ÷4.5 GeV/c



Λ proton momentum GeV/c



Λ_b proton momentum GeV/c

That corresponds to the 40% of our proton sample from Λ_b

Our goal: proton tagging using PID (Tof + dE/dx)

Tof reconstruction

- We use Official Tof Reconstruction
  - Tzero set NegLog
  - Pulses set Simples
  - Pulses_useTOFDCuts set true
  - Pulses_minAdcCut set 0
  - Pulses_minTdcCut set 0
  - Extrapolator set Geometric
  - Associator set TLR

Proton Tof correction for Λ lifetime

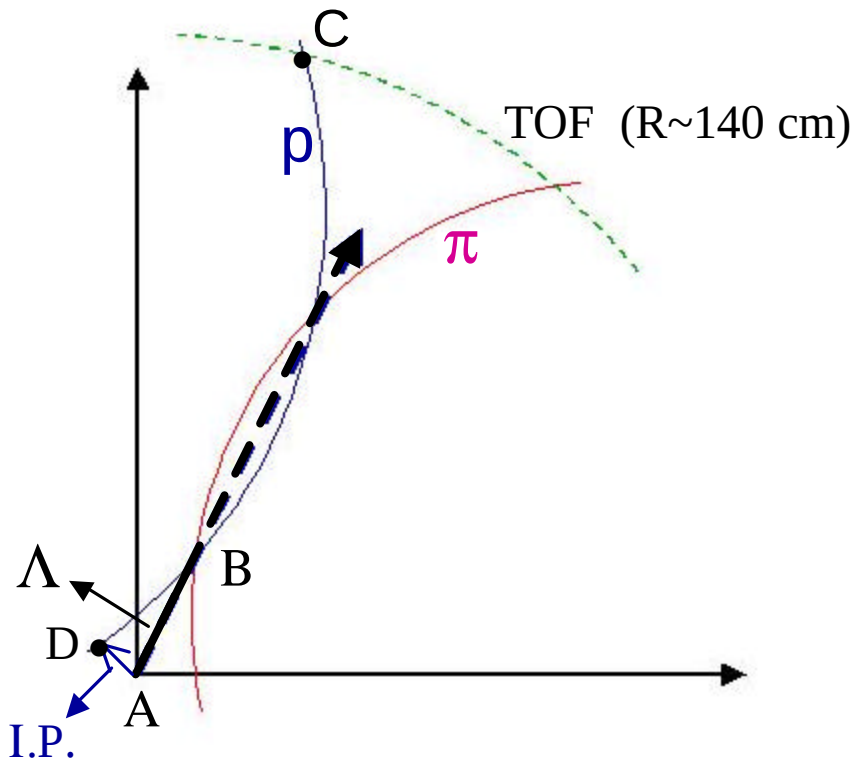
$$\mathrm{Tof}_p^{\mathrm{Measured}} = \mathrm{Tof}^{\mathrm{AB}}(\Lambda) + \mathrm{Tof}^{\mathrm{BC}}(p)$$

$$\mathrm{Tof}_p^{\mathrm{Measured\,(corr)}} = \mathrm{Tof}_p^{\mathrm{Measured}} - \mathrm{Tof}^{\mathrm{AB}}(\Lambda)$$

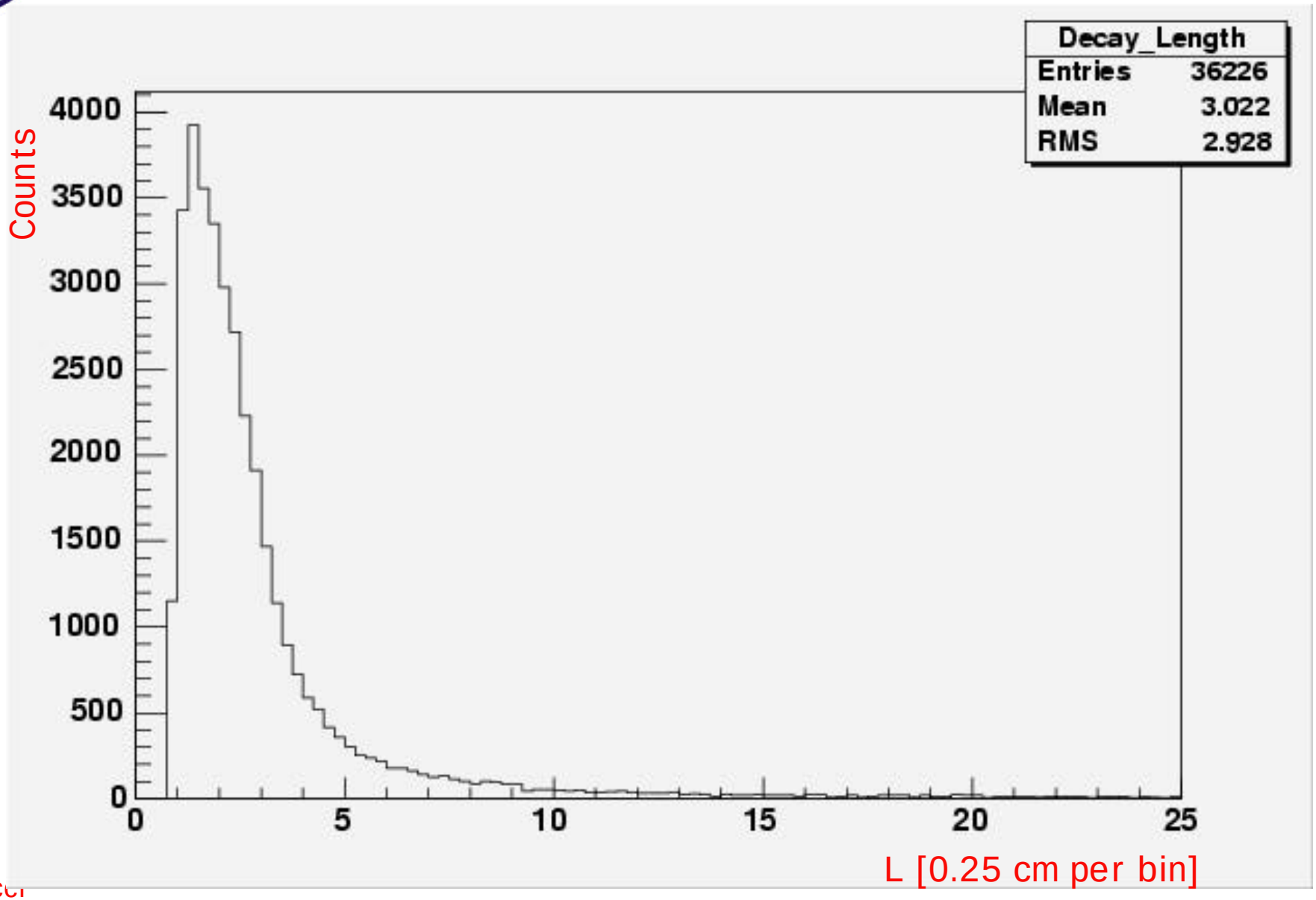
$$\mathrm{Tof}^{\mathrm{AB}}(\Lambda) = \frac{L_{xy}^{\Lambda}}{\sin\theta_{\Lambda}}\frac{1}{\beta_{\Lambda} c}$$

$$\mathrm{Tof}_p^{\mathrm{exp}} = \frac{L_{DC}^{\mathrm{helix}}}{\beta_p c}$$

$$\mathrm{Tof}_p^{\mathrm{exp\,(corr)}} = \frac{L_{BC}^{\mathrm{helix}}}{\beta_p c}$$

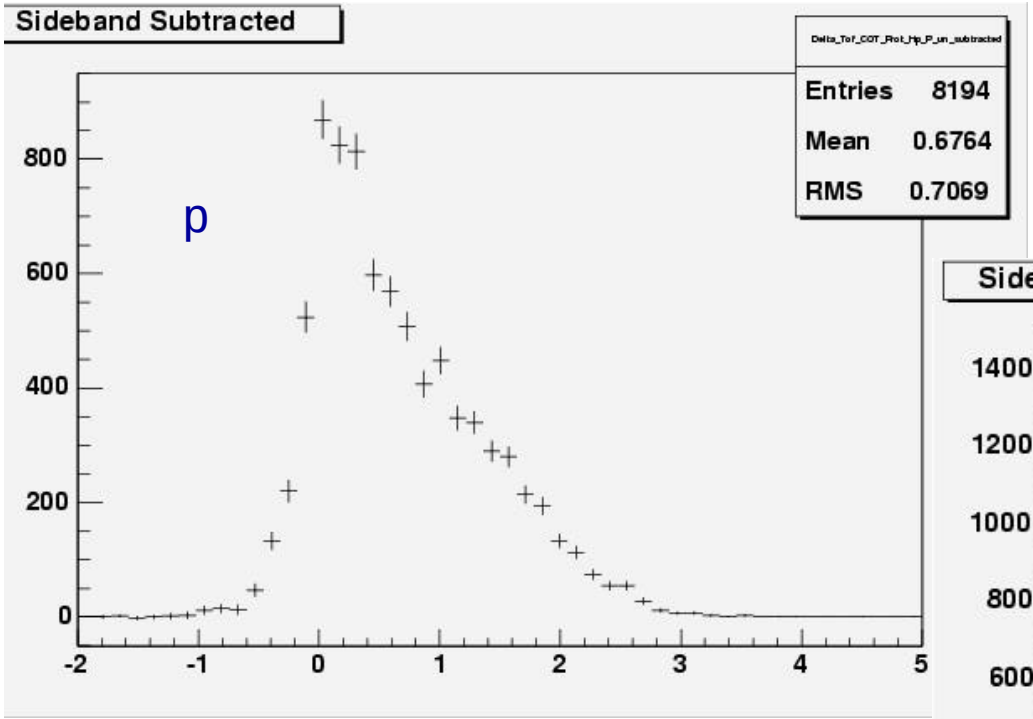


Λ decay Length

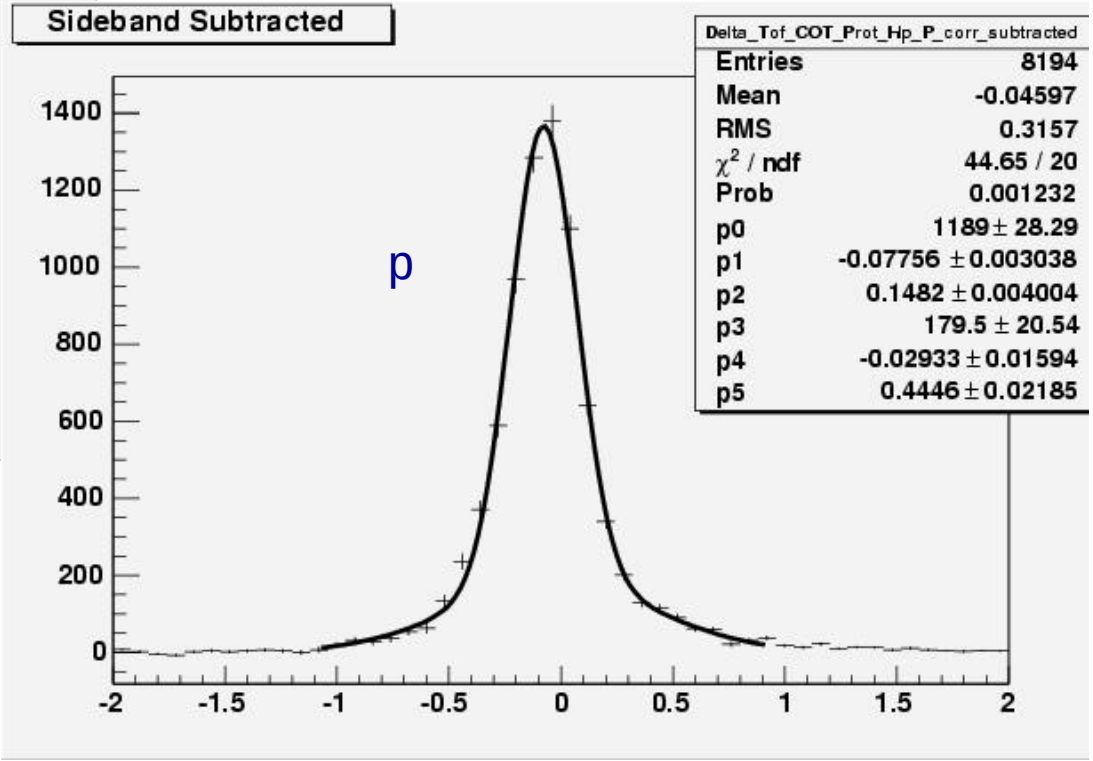


Proton Tof resolution using Λ lifetime correction

- All analysis cuts
- p with associated Tof
- Sidebands subtracted

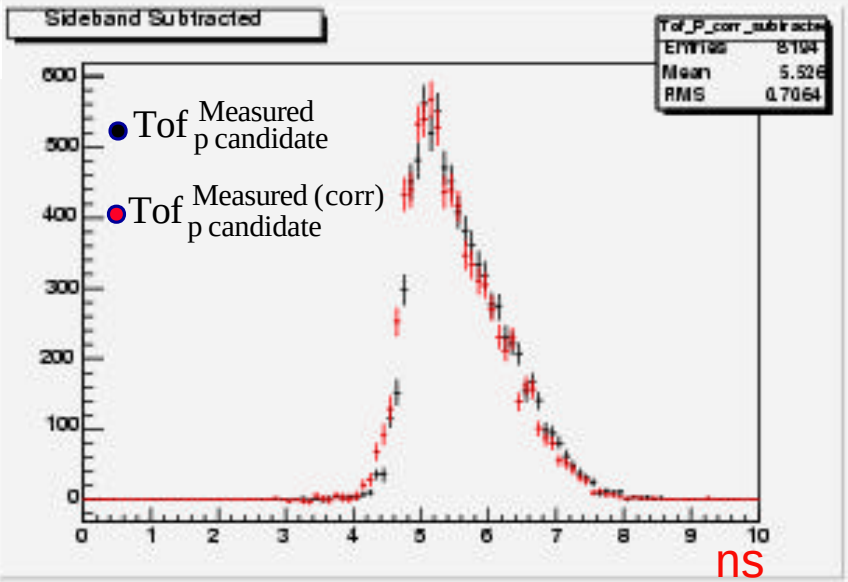


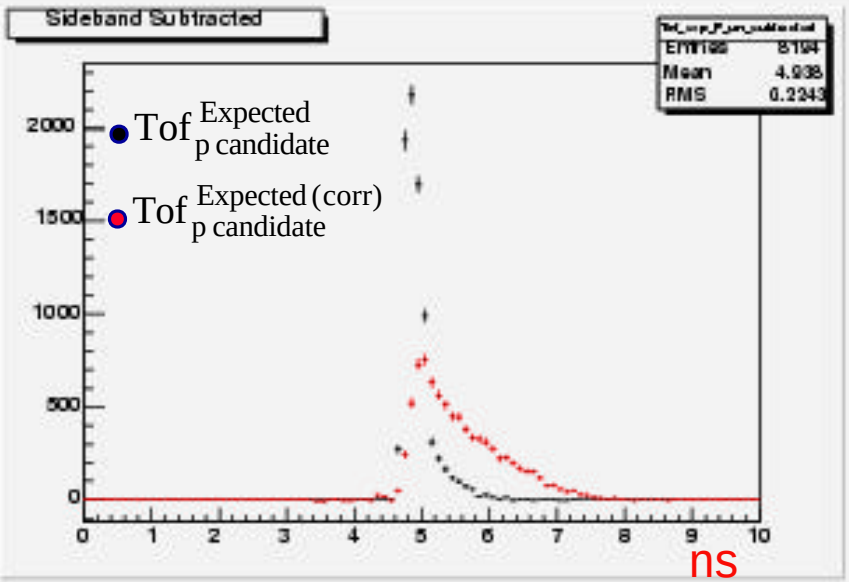
$$\mathrm{Tof}^{\mathrm{Measured}}_{\mathrm{p\ candidate}} - \mathrm{Tof}^{\mathrm{Expected}}_{\mathrm{p\ Hypothesis}} \quad [\mathrm{ns}]$$

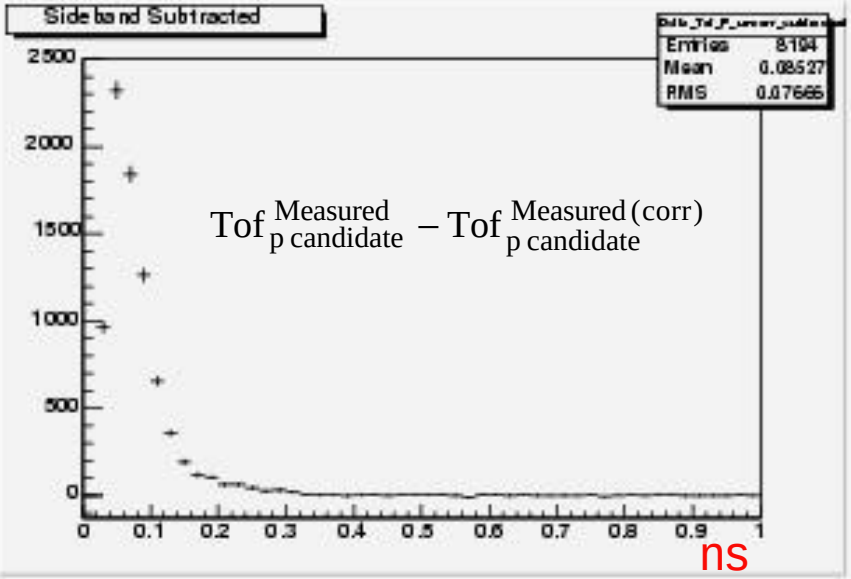


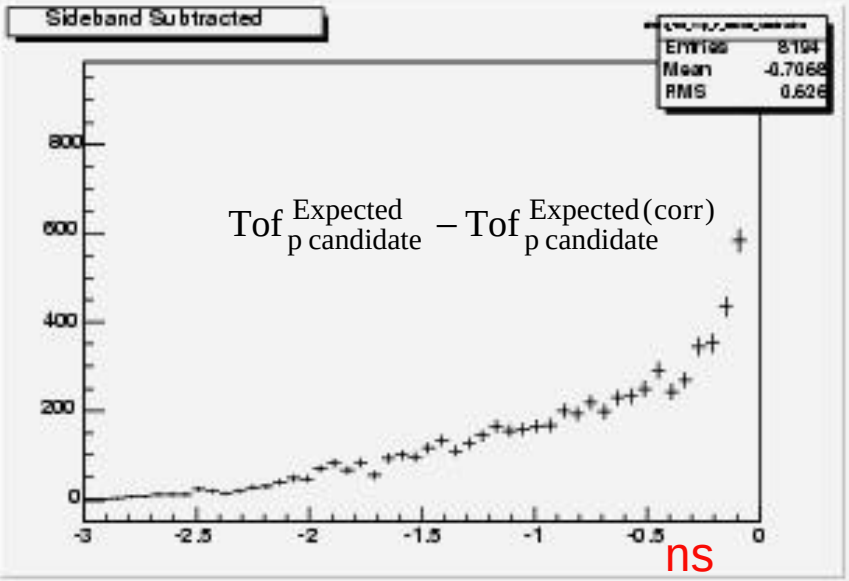
$$\mathrm{Tof}^{\mathrm{Measured\,(corr)}}_{\mathrm{p\ candidate}} - \mathrm{Tof}^{\mathrm{Exp(corr)}}_{\mathrm{p\ Hypothesis}} \quad [\mathrm{ns}]$$

Tof Measured and Tof Expected



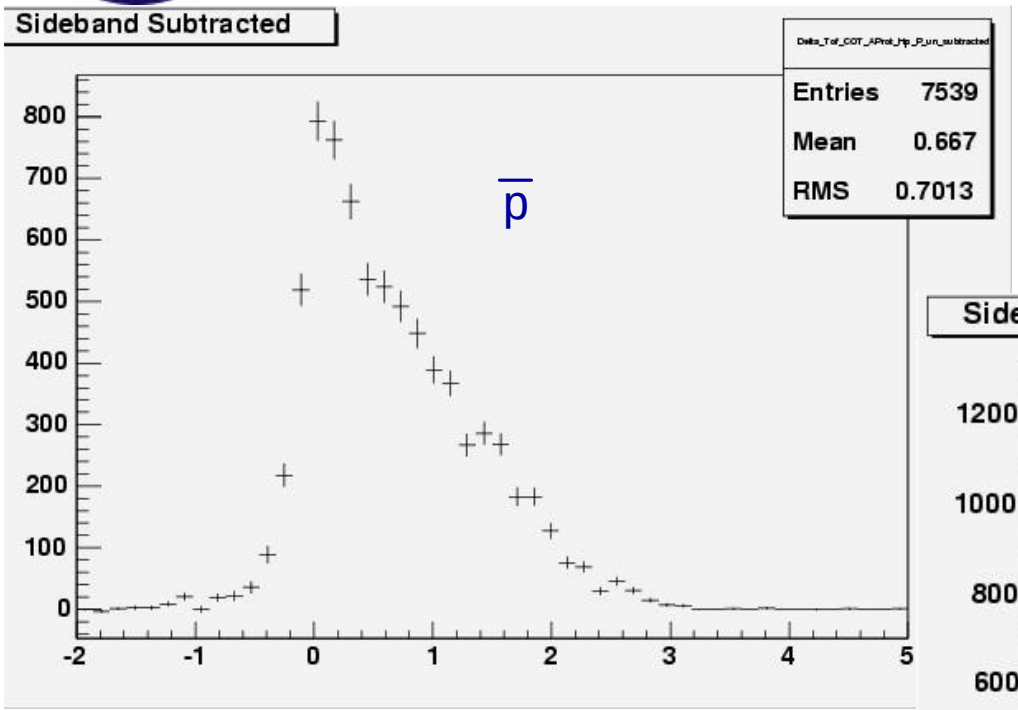




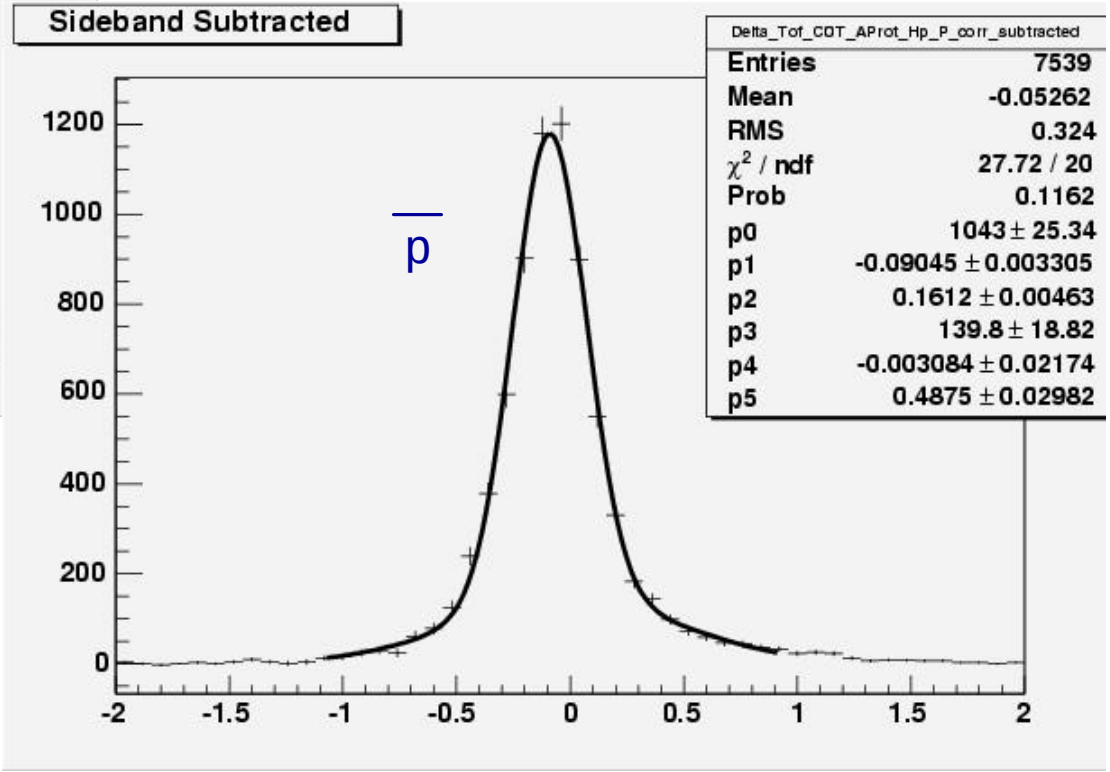


Proton Tof resolution using Λ lifetime correction

- All cuts analysis cuts
- $\bar{p}$ with associated Tof
- Sidebands subtracted

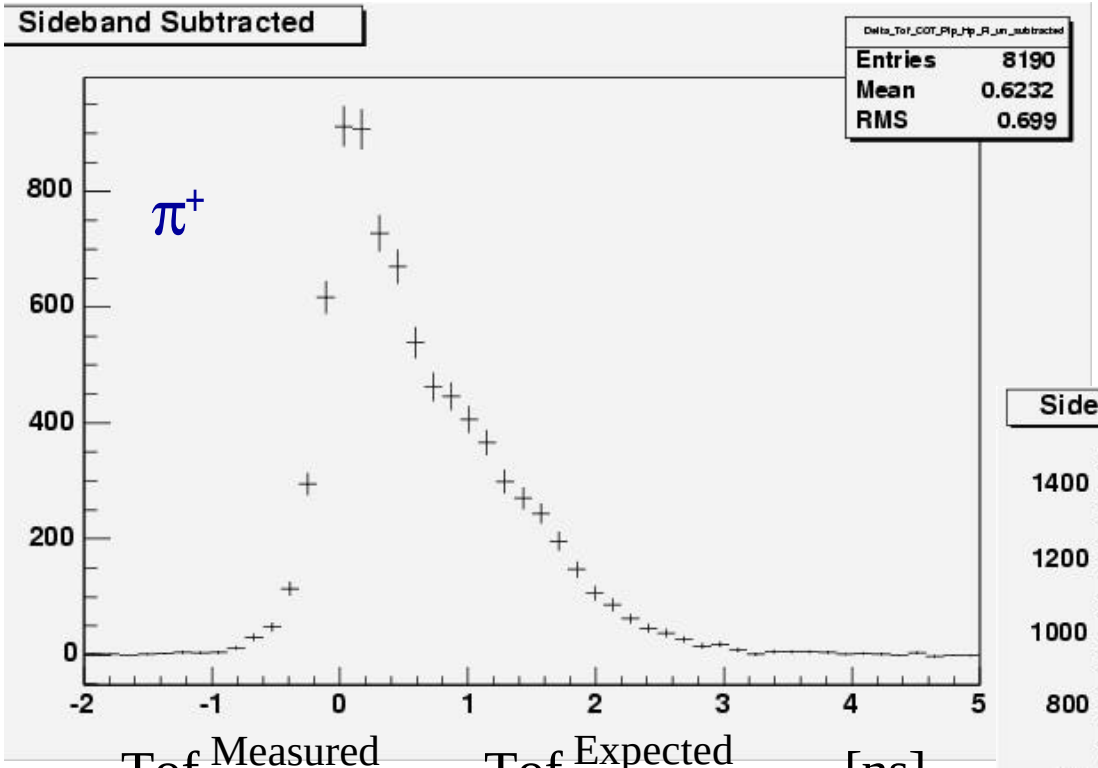


$$\mathrm{Tof}^{\mathrm{Measured}}_{\bar{p}\ \mathrm{candidate}} - \mathrm{Tof}^{\mathrm{Expected}}_{p\ \mathrm{Hypothesis}} \quad [\mathrm{ns}]$$

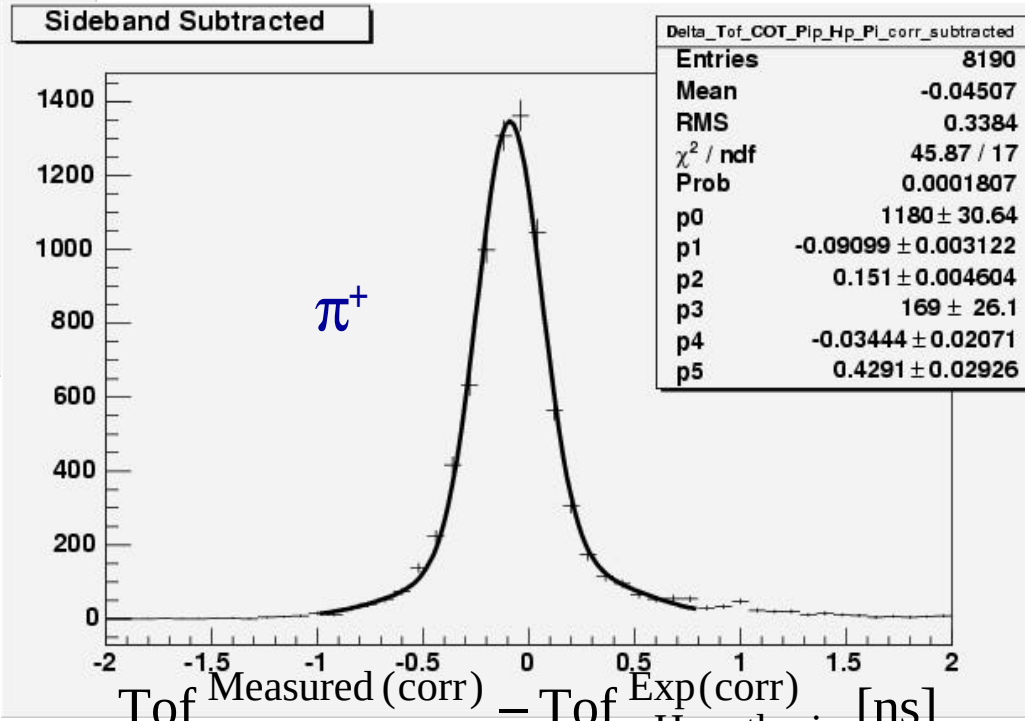


$$\mathrm{Tof}^{\mathrm{Measured\,(corr)}}_{\bar{p}\ \mathrm{candidate}} - \mathrm{Tof}^{\mathrm{Exp(corr)}}_{p\ \mathrm{Hypothesis}} \quad [\mathrm{ns}]$$

π^+ Tof resolution using Λ lifetime correction

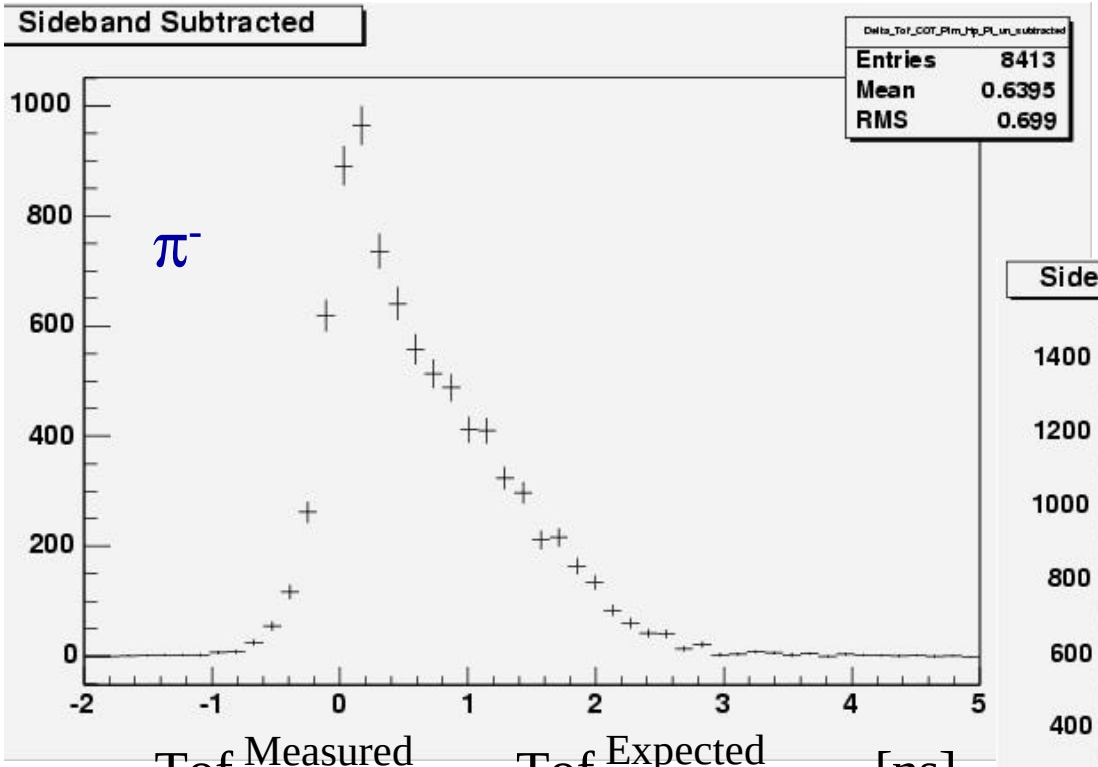


$\mathrm{Tof}^{\mathrm{Measured}}_{\pi^+\ \mathrm{candidate}} - \mathrm{Tof}^{\mathrm{Expected}}_{\pi\ \mathrm{Hypothesis}}$ [ns]

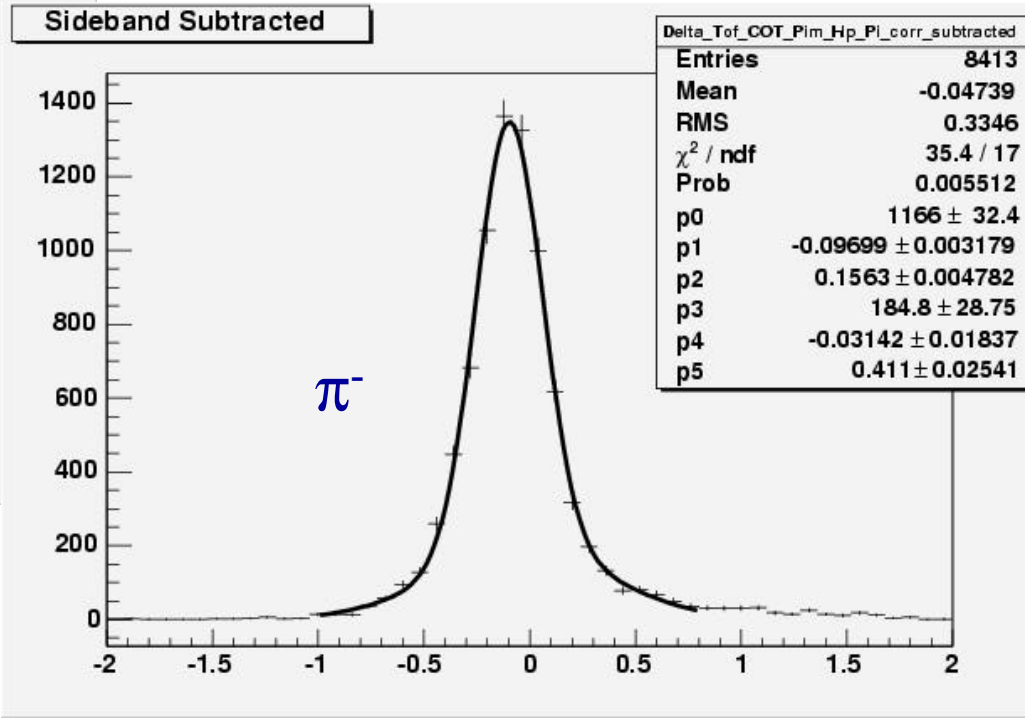


$\mathrm{Tof}^{\mathrm{Measured\ (corr)}}_{\pi^+\ \mathrm{candidate}} - \mathrm{Tof}^{\mathrm{Exp(corr)}}_{\pi\ \mathrm{Hypothesis}}$ [ns]

π^- Tof resolution using Λ lifetime correction

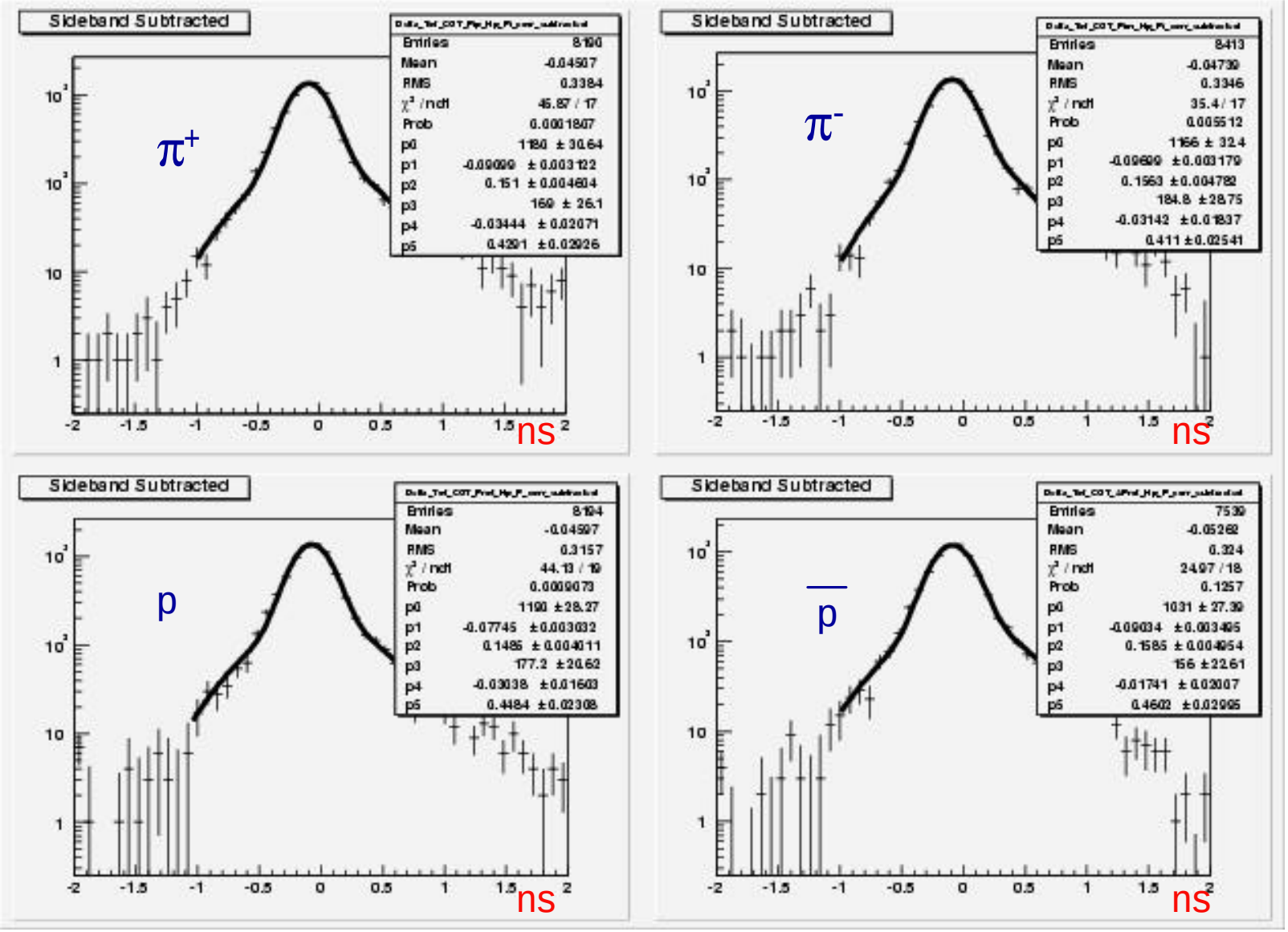


$$\mathrm{Tof}^{\mathrm{Measured}}_{\pi^- \text{ candidate}} - \mathrm{Tof}^{\mathrm{Expected}}_{\pi \text{ Hypothesis}} \quad [\mathrm{ns}]$$



$$\mathrm{Tof}^{\mathrm{Measured\,(corr)}}_{\pi^- \text{ candidate}} - \mathrm{Tof}^{\mathrm{Exp(corr)}}_{\pi \text{ Hypothesis}} \quad [\mathrm{ns}]$$

Tof resolution using Λ lifetime correction



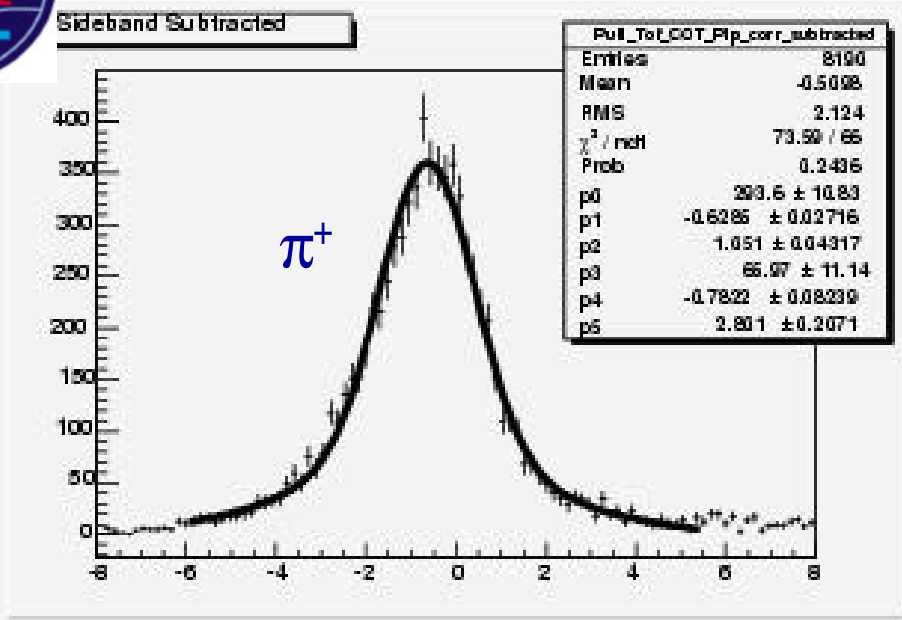
Tof Pull distribution

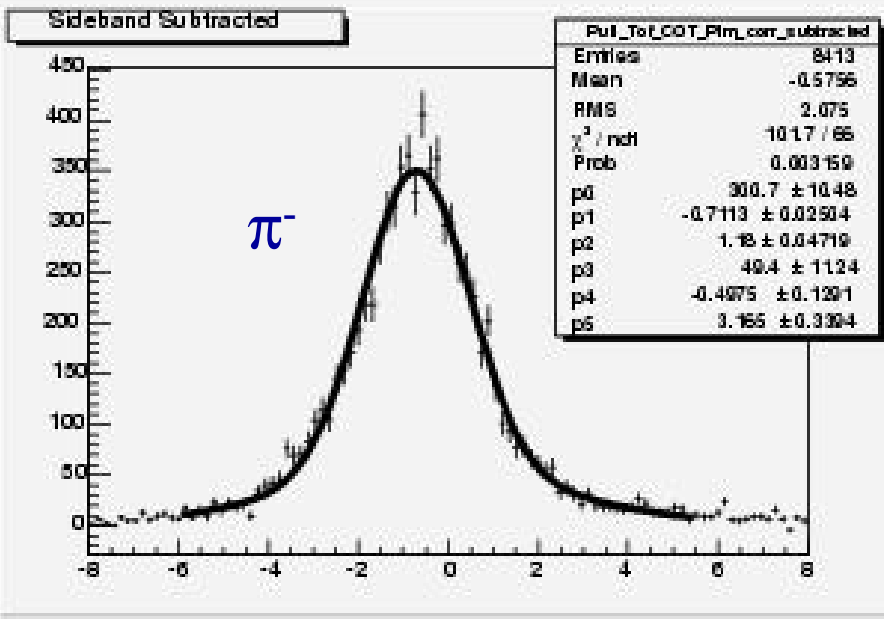
For each Λ combination in the signal region we evaluate the Pull for pion and proton hypothesis

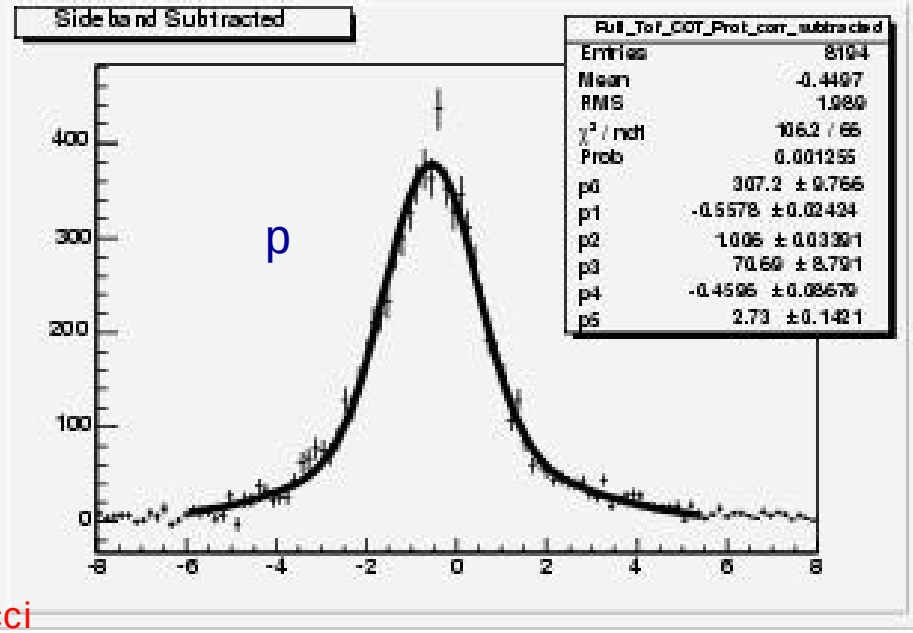
$$\mathrm{Pull}_{\text{particle Hypothesis}} = \frac{\mathrm{Tof}^{\text{Measured (corr)}}_{\text{candidate}} - \mathrm{Tof}^{\text{Exp(corr)}}_{\text{particle Hypothesis}}}{\sigma_{\mathrm{Tof}^{\text{Measured}}_{\text{candidate}}}}$$

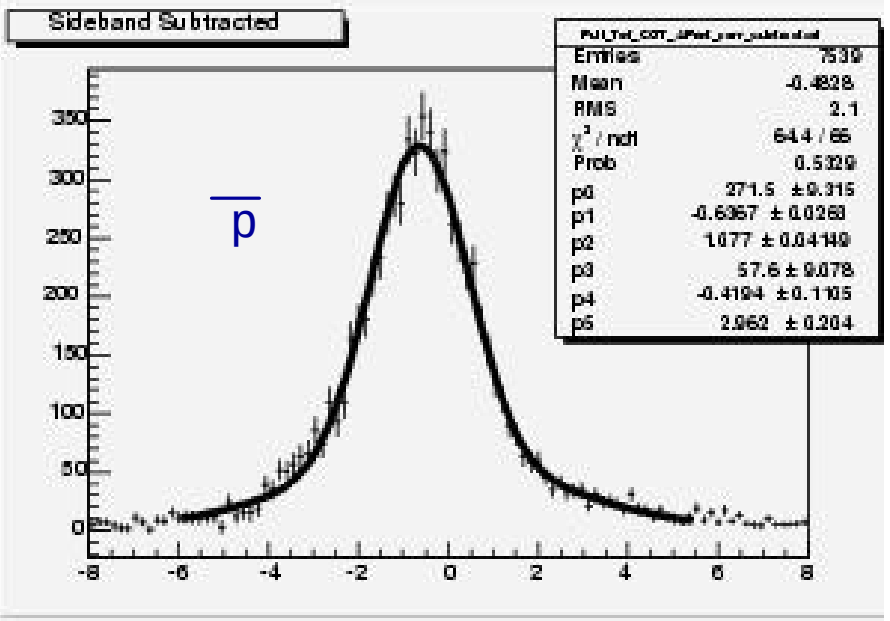
Where σ_{Tof} is the error on Tof measured (uncorrected)

Tof Pull distribution



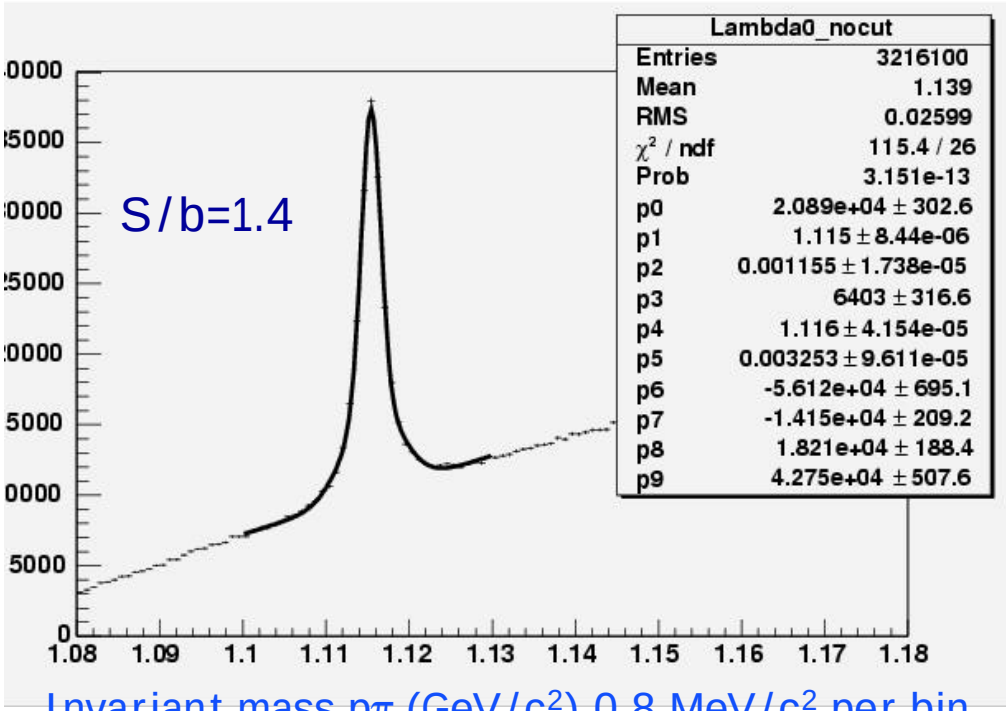






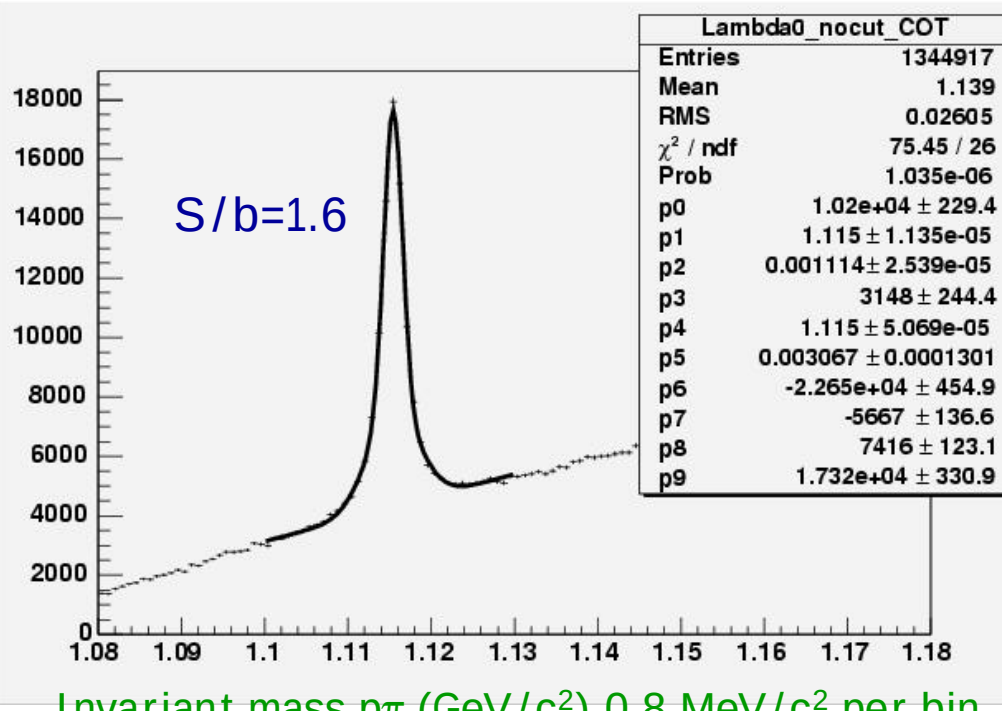
Single track tof association efficiency $\varepsilon_{tof} \cong 50\%$

Only standard cuts on V^0 selection



Invariant mass pπ (GeV/c^2) 0.8 MeV/c^2 per bin

Only standard cuts V^0 selection
and proton candidate with associated Tof

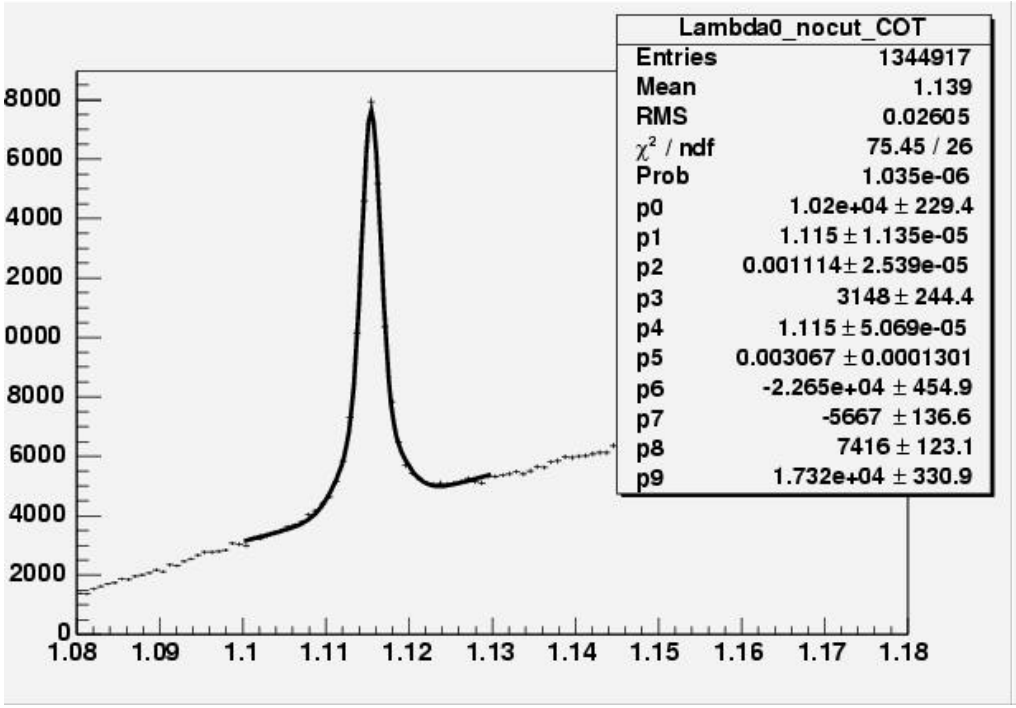


Invariant mass pπ (GeV/c^2) 0.8 MeV/c^2 per bin

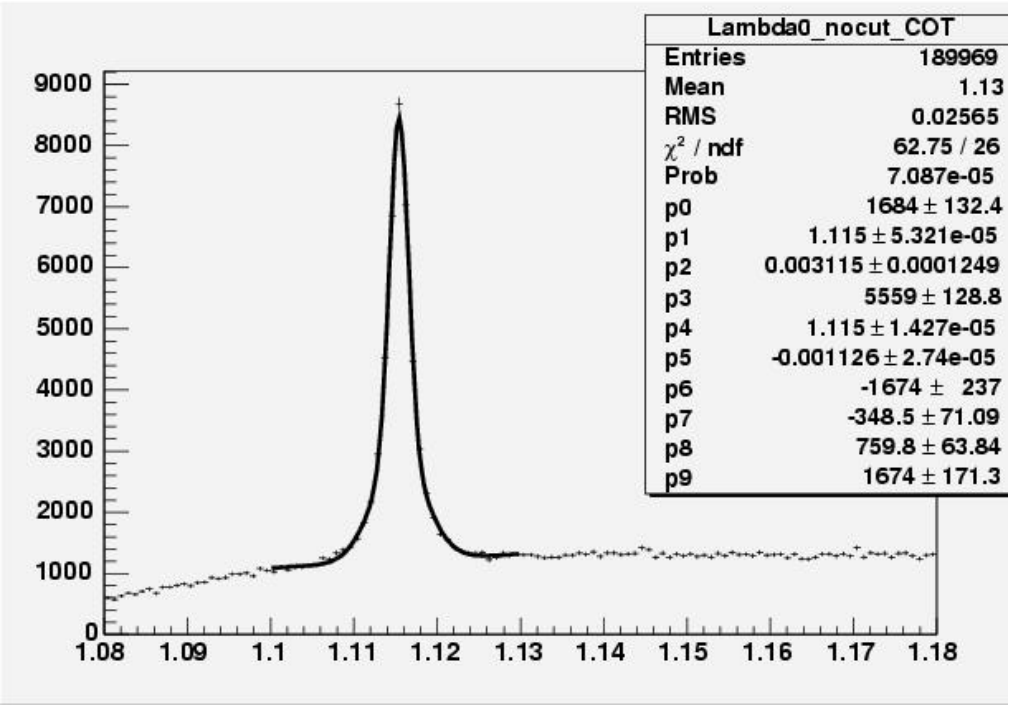
Single track tof association
efficiency $\varepsilon_{tof} \cong 50\%$

Cutting at one σ on proton Hypotesis...

$$\left| \mathrm{Tof}^{\mathrm{Measured}}_{\mathrm{p\ candidate}} - \mathrm{Tof}^{\mathrm{Expected}}_{\mathrm{p\ Hypothesis}} \right| < 1\sigma$$



Invariant mass pπ (GeV/c²) 0.8 MeV/c² per bin



Invariant mass pπ (GeV/c²) 0.8 MeV/c² per bin

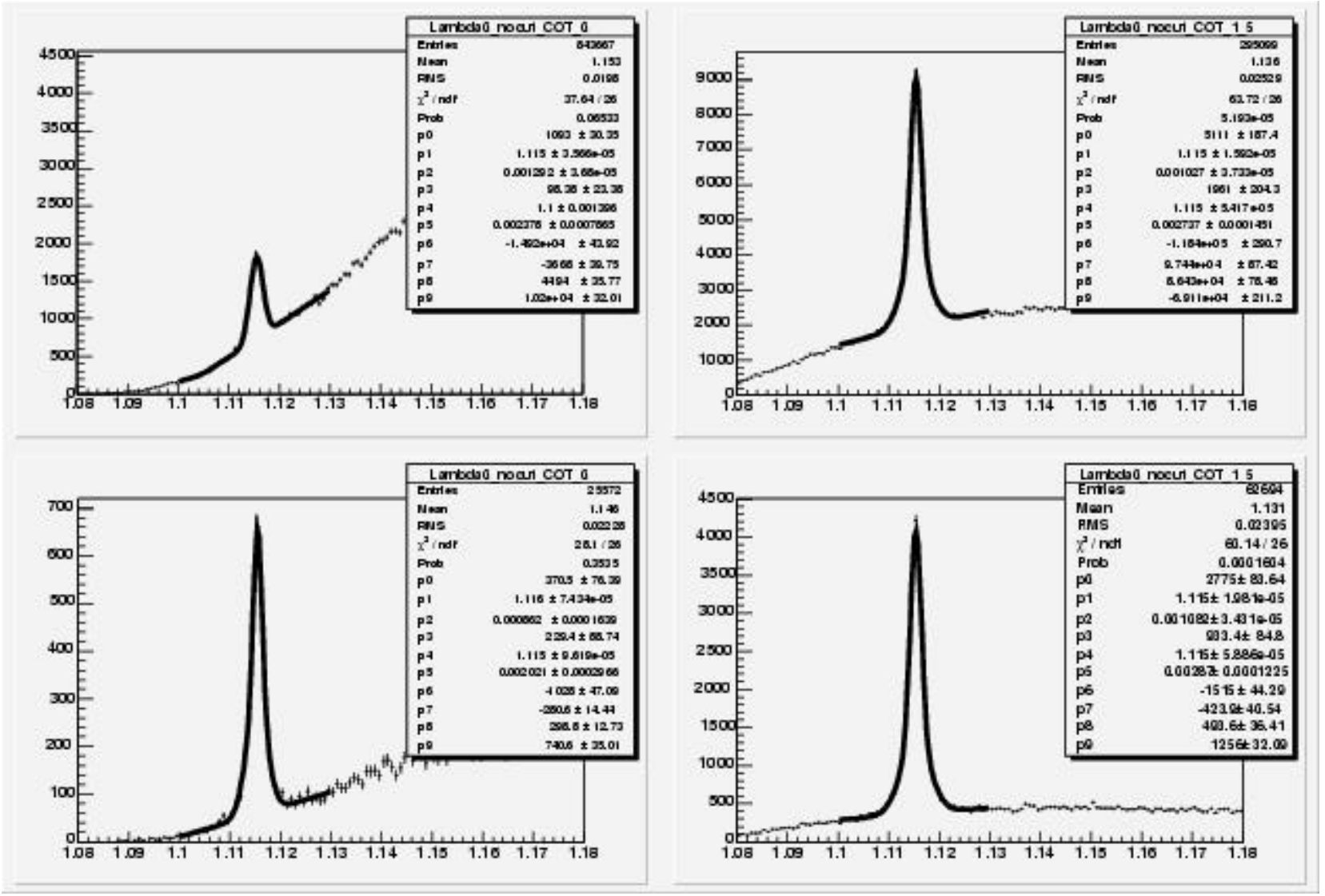
Invariant mass distribution in momentum bin before and after cut at one σ

P < 1.5 GeV/c

1.5 < P< 3 GeV/c

before

after

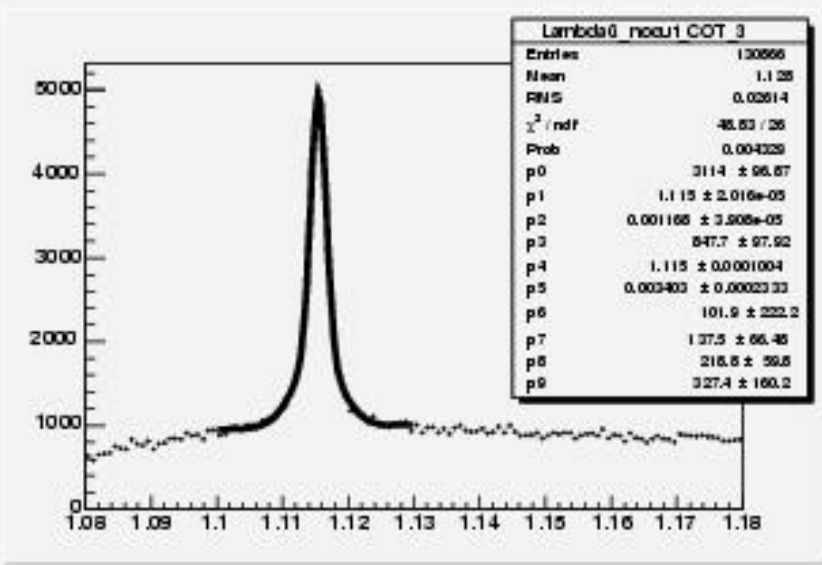


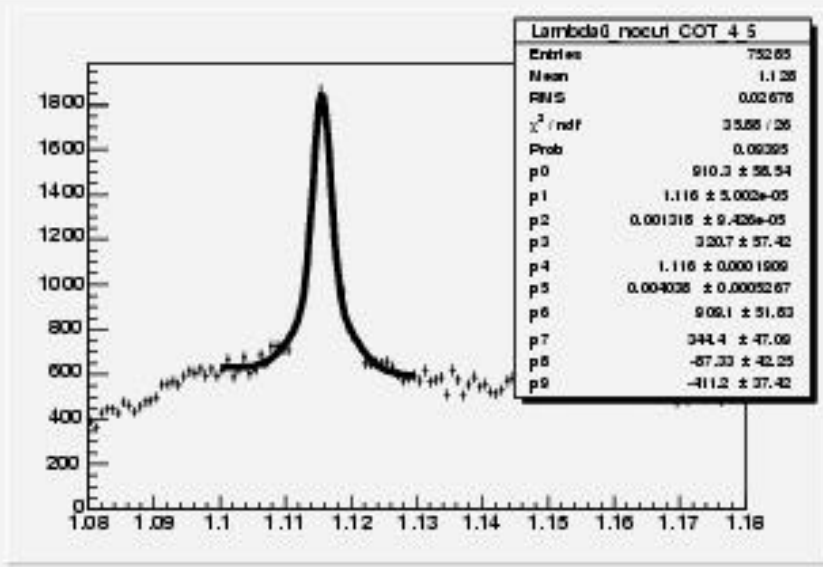
Invariant mass distribution in momentum bin before and after cut at one σ

3< P < 4.5 GeV/c

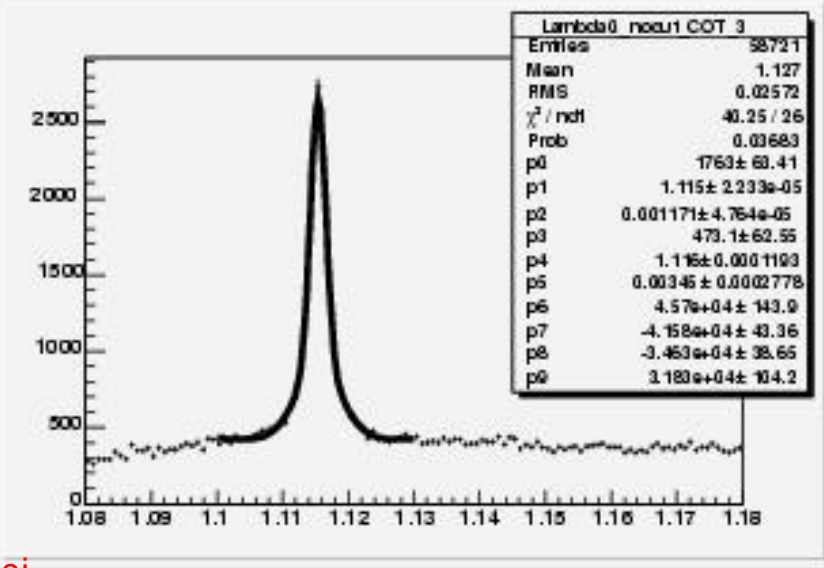
P> 4.5 GeV/c

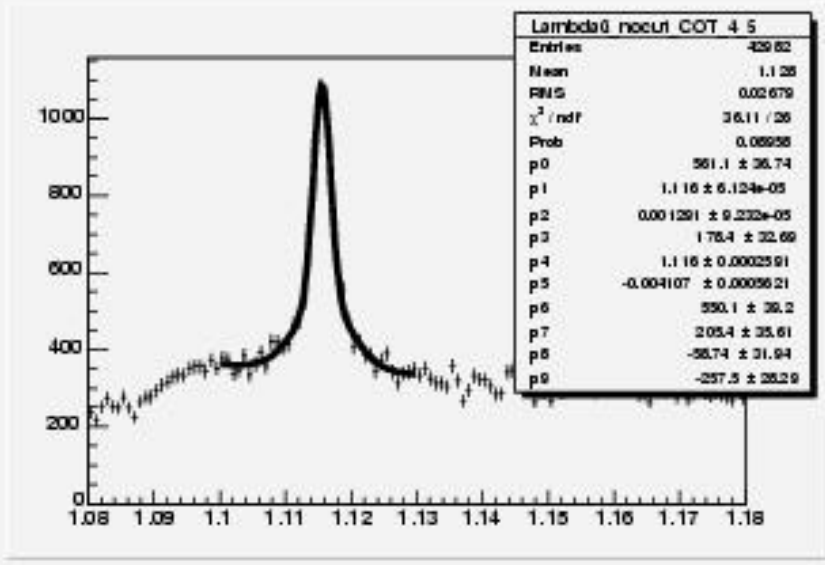
before





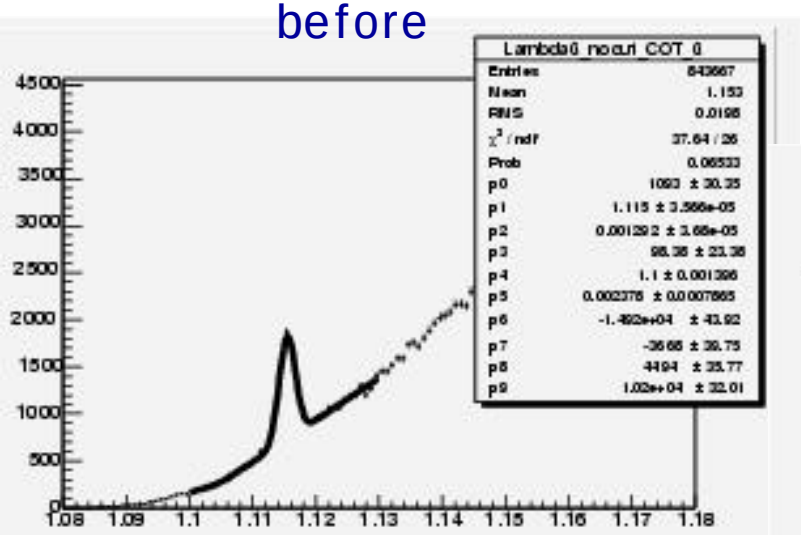
after



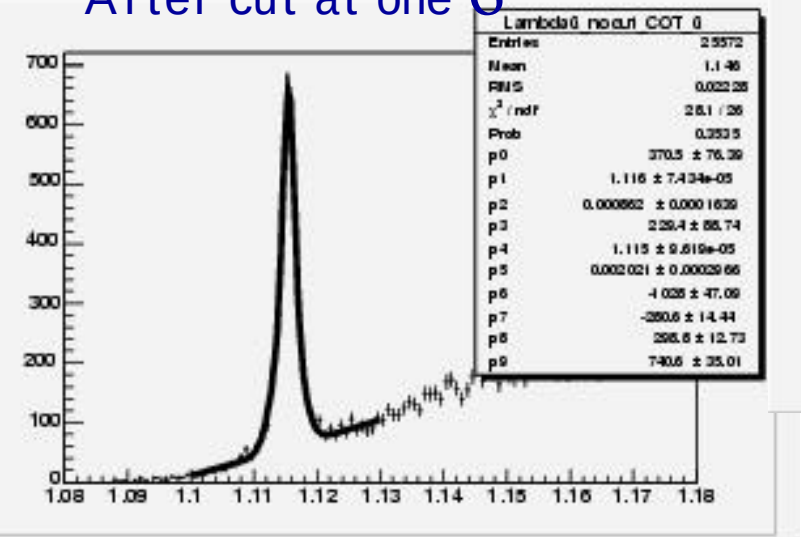


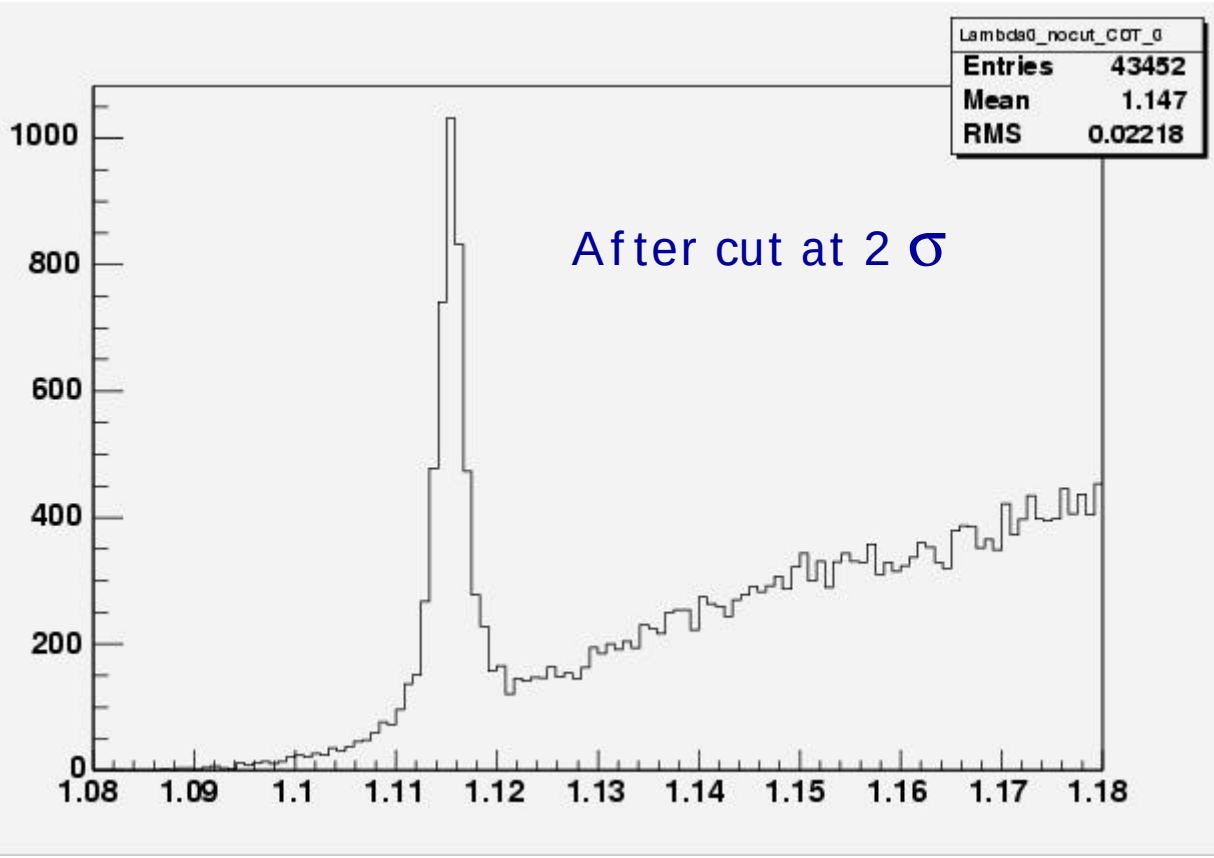
P < 1.5 GeV/c

before



After cut at one σ





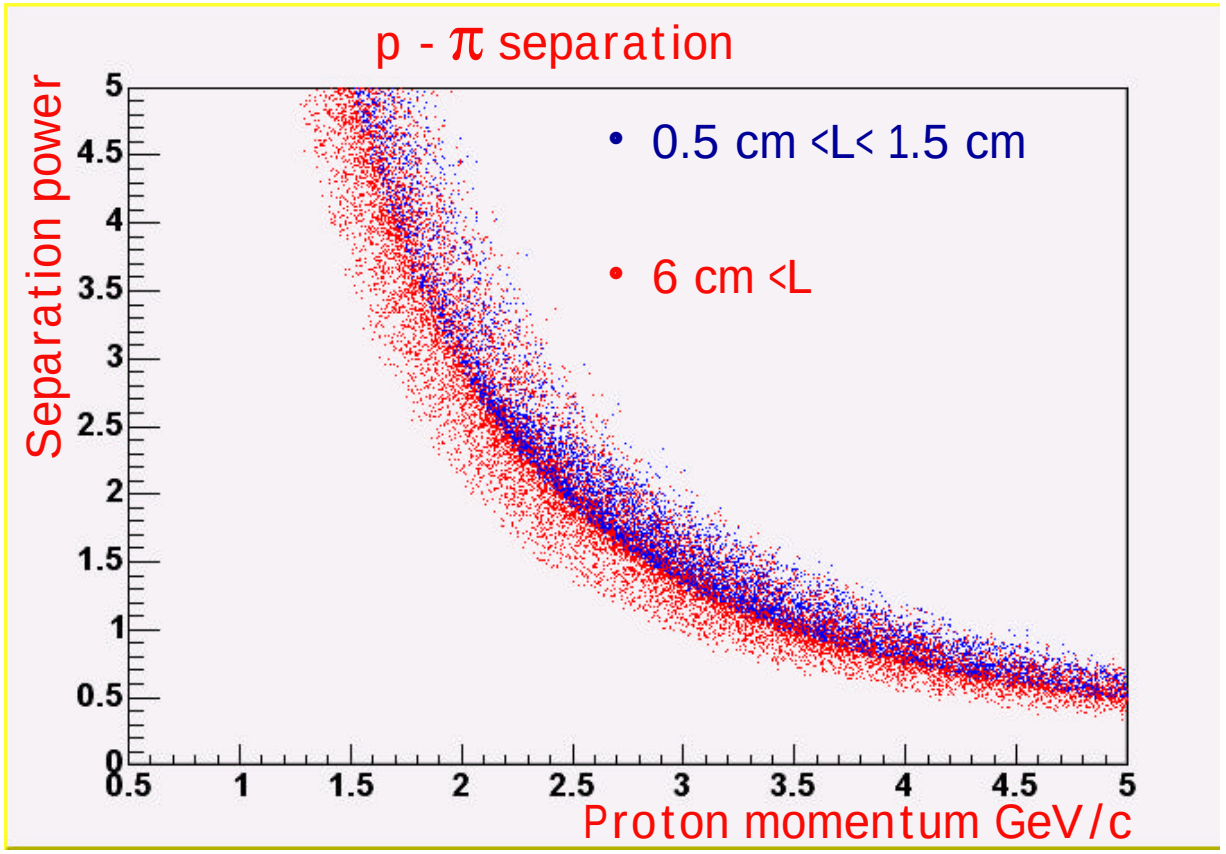
Separation power

Separation power expected is defined as

$$\frac{\left| \mathrm{Tof}^{\mathrm{Expected(corr)}}_{\mathrm{p\ Hypothesis}} - \mathrm{Tof}^{\mathrm{Expected(corr)}}_{\pi\ \mathrm{Hypothesis}} \right|}{160\ \mathrm{ps}}$$

Separation power expected between pion and proton, assuming a resolution of 160 ps, depends on the track path length

greater is the Λ decay length (L) smaller is the track path length



Conclusion and to-do's

- We applied correction on p Tof due to the Λ time of flight
- We estimate a σ_{Tof} of 160 ps with an offset on mean of 80 ps
- The Tof expected (found in the bank) seems to be underestimated
- The Pull has two gaussian contribution

after the correction reported here it works quite well

next step …

use the K^0 sample to select a pure pion sample to understand Tof separation power p-π

[3] www-cdf.fnal.gov/internal/physics/bottom/reco-tag/TALKS/030606/